

LOS
ANGELES
COUNTY
MUSEUM

CONTRIBUTIONS IN SCIENCE

NUMBER 124

MAY 31, 1967

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(Hymenoptera: Formicidae)

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STATUS OF *PROCRATIUM CALIFORNICUM* COOK
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ABSTRACT: Based upon the type male, *Proceratium californicum* Cook is redescribed. The presumed females are described for the first time and the relationships to the species of the Old World and New World are discussed. A key to the workers and females of described New World *Proceratium* is provided.

In his book *The Ants of California*, Cook (1953) described several taxa as new. All of these, with the exception of *Proceratium californicum*, have since been synonymized with common, well-known species (Wilson, 1955; Cole, 1967). The identity of the *Proceratium* presented difficulties which, while not yet solved, can now be somewhat clarified.

HISTORICAL RESUME

As its name implies, this species was originally based on a specimen from California. Brown (1958) indicated caution in acceptance of this record, since there were no prior records of *Proceratium* in the United States from west of the Great Plains. The members of this genus are all cryptobiotic in their habitats and show a decided preference for areas which maintain high summer humidity. There are few areas in California which can satisfy this requirement; the type locality of *P. californicum* (the Santa Cruz Mountains) is one such area. On this basis, at least, it was not too unreasonable to expect a species of *Proceratium* to occur here.

The species was described from a single male specimen. Males of *Proceratium* are extremely rare in collections, and Cook's inadequate and inaccurate original description indicated no characters by which his species could be separated from the males of the eastern forms. The figures given by Cook are poorly executed, but at least offered clues lacking in the verbal description.

During recent years several alate females of a distinctive *Proceratium* have been taken in California, but it has not been possible to secure any workers or additional males. Nonetheless, for reasons which I hope to justify below, I believe these to be conspecific with *P. californicum*. Before going further into a discussion of these females it is pertinent to review the status of the male which Cook originally described.

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At the time Cook's publication appeared two similar and closely allied genera were recognized in the eastern United States, *Proceratium* and *Sysphincta*. For American workers, at least, the generic distinctions were obvious and clear-cut in the workers and females; M. R. Smith (1943) indicated equally sound characters for the males. In the latter caste, the main character used was wing venation. Not mentioned by Smith, but equally distinctive, is the clypeal configuration. In all castes of *Sysphincta* the clypeus possesses a distinct anterior median projection and the petiole is more or less nodiform (although this was recognized to be somewhat variable).

A cursory examination of Cook's figures show a distinctly projecting clypeal margin, a somewhat nodiform petiole and wing venation typically that of *Sysphincta*. Had any competent myrmecologist examined this specimen it would have been placed in that genus without hesitation. Cook was aware of Smith's work on male ants, having referred to it several times and taken a number of the illustrations directly from his paper, so it seems strange that he could have missed such obvious differences as were used to separate the two genera. Nowhere in his discussion of *Proceratium* does Cook make any mention of *Sysphincta*; neither did he attempt to compare his ant with any then placed in that genus.

Following a critical examination of nearly all the described species of *Proceratium* and *Sysphincta*, Brown (1958) found that the supposed generic differences would not hold up, as all the characters show graduation from the *Proceratium* extreme to the *Sysphincta* extreme. Accordingly Brown synonymized *Sysphincta* under *Proceratium*.

Attempts to recognize *P. californicum* from either Cook's description or figures prove futile. The textual comments are inaccurate and misleading and the figures bear little resemblance to the type specimen. The type, now the property of the Snow Museum, Oakland, California, has been made available to me, and with this specimen at hand, it is now possible to unravel some of the confusion and present a more detailed account of the species. Although I find it distasteful to review and criticize the original description in such detail as follows, I feel that if this is not done that there will remain the possibility of further confusion in the future.

CRITIQUE OF COOK'S ORIGINAL DESCRIPTION AND A REDESCRIPTION OF *PROCERATIUM CALIFORNICUM*

Cook gave the length of the type specimen as 3.5 mm. I have carefully measured this individual, and arrive at a length of 4.25 mm; the distance from the anterior ocellus to the thoracic-petiole articulation is 2.0 mm, the petiole measures 0.4 mm, and the abdomen (with apical segments reflected downward) is 1.85 mm. The statement that the head length (HL) is about equal to head width (HW) is correct; the HL is 0.82 mm, while HW is 0.84 mm, so that HW slightly exceeds HL. In specimens of *P. croceum* (Roger) HL is

0.60 mm and HW is 0.65 mm; according to Cook, the head of *P. californicum* is "broader than in *croceum*," while the above figures show the reverse to be true. Cook's next statement that the antennae are 12-segment is refuted by his figure of a 13-segmented antenna. Male ponerines typically possess 13-segmented antennae and there is no reason to suppose that *P. californicum* is an exception, particularly since the males of other *Proceratium*, so far as known, follow the rule. Unfortunately the type lacks the right funiculus and the entire left antenna. However, in the figure the funicular segments appear much too long (twice as long as broad), while typically they are hardly longer than broad in males of this genus. Since the facial view included only the right scape, the left antenna of the lateral view may be an illustrative addition to make the specimen complete. In the figure of the head the scape is shown distinctly longer than is actually the case. The statement that the scape is "equal in length to the last three segments of the funicle" can be neither proven nor disproven, although the figure shows the scape to be slightly longer; the scape is 0.42 mm long. The remaining cephalic features mentioned are correctly described, *i. e.*, the posterior margin of the head is rounded, three ocelli are present, the eyes are large and prominent, the well-developed mandibles are edentate with pointed apex. These characters are common to all *Proceratium* males. The eye length is 0.37 times HL and the distance from the lower eye margin to the mandibular insertion is about equal to one-third of the eye length (6:19); the upper eye margin is slightly below the midpoint of the HL.

The thorax is said to be short and massive. The thoracic length is 1.5 mm, maximum height is 1.2 mm and maximum width is 0.90 mm. I would not consider the thorax to be "short and massive" since the length exceeds both its height and width. Cook's statement that the pronotum has distinct humeral angles is baffling, for I cannot discern anything resembling humeral angles. The statement that the anteromedian part of the mesoscutum is distinctly truncated is also confusing. I assume that he had reference to the dorsal portion adjoining the promesonotal suture; this however is evenly convex. In spite of the claim that there is a large, rounded tubercle terminating centrally on the mesonotum, no such tubercle exists. Presumably this was in error for the metanotal tubercle, which is not large, and is rounded only in lateral aspect. From above it is pointed behind with a distinct median longitudinal carina.

The remaining gross characters are more or less correctly described, though without offering any distinctive features. In discussing the integument, his remark that most of the body is subopaque is not correct. Everywhere, except on the frons and epinotum, the surface is distinctly shining between the sculpturation. The cephalic sculpture is said to be fine, but the punctures are about equal to those of the thorax, where they are stated to be heavy and well-defined. On the frons and middle portions of the vertex the punctures are a little finer and much denser than elsewhere on the head; here the surface texture is roughened, but still there are sufficient shining raised interspaces that the aspect, on the whole, is that of a somewhat shining surface. The

punctures on the lower part of the face are irregularly linearly arranged, generally convergent toward the apex. The cheeks are crossed by a few very fine transverse striolae. The mandibles are shining, with numerous punctures a little larger than those of the adjacent portions of the face. The apical margin of the median clypeal lobe is acutely produced, with a pair of posteriorly convergent fine carinulae on its dorsal face.

The pronotum is reticulopunctate, with the surface distinctly shining and the punctures equal in size to those of the lower part of the frons. The mesopleurae are shining, with distinct punctures which are much denser below, especially anteriorly and posteriorly. The mesoscutum is densely punctate with distinct shining interspaces. The mesoscutellum is more strongly convex in lateral aspect than Cook's figure shows; the punctuation is much like that of the mesoscutum. The epinotum is distinctly duller than the remainder of the thorax and is densely reticulopunctate. The figure of the petiolar node is inaccurate as it shows the anterior face more steeply sloping than is actually the case, and the node is too thick from front to back. The postpetiole is densely punctate, and the remaining gastric segments are a little shinier and more sparsely punctate.

The pubescence, both appressed and erect, is everywhere yellowish, not dark reddish-brown. The integument is dark reddish-brown. The wings are hyaline, very slightly whitish, with very pale yellowish veins and amber stigma. The hind wing has nine hamuli.

THE TYPE SPECIMEN

The above commentary of conflicting statements was based upon the type specimen, the only known male of this species. Cook cited the data for this specimen as follows: "Glenwood in the Santa Cruz Mountains (T. W. Cook, 1950)," thus suggesting that he collected the specimen. In fact, the male bears the following data: "Glenwood Cal./27 May 1908." Dr. W. L. Brown has suggested (*in litt.*) that this specimen was "probably a Bradley-collected specimen from the MCZ." However, I have seen other insects with an identical label in the Stanford University collection, to which Cook had access. This male bears, in addition, two other penciled labels in Cook's handwriting. These read: "PROCERATIUM/sp./DRAWN" and "*Proceratium/californicum*/T. W. Cook/Described," indicating beyond any doubt that this is the type of *P. californicum*.

ADDITIONAL MATERIAL

I have before me four female *Proceratium* from three widely separated California localities. One female is from Yuba City, Sutter Co., 27 April 1965, collected by W. Wiard while sweeping mixed *Rumex* and *Avena* on a ditch levee. The second specimen was taken at Valle Vista, Oakland, Alameda Co., 21 April 1918, collector not indicated but probably J. C. Bradley. Two females are from the Santa Monica Mts., Los Angeles Co., 19 April 1959, collected by



Figure 2. Fluorescence images of an intact, unstained embryo at time of 10 minutes post-fertilization. (a) shows the location of the zygote, (b) shows a higher magnification view of the zygote, and (c) shows a higher magnification view of the zygote.

an entomology student from the University of California at Los Angeles; according to Dr. J. N. Belkin the specimens were most likely taken at Tapia Park in Malibu Canyon. This park is a favored site for school field trips. Unfortunately, recent changes in the Tapia Park area have completely demolished the most likely sites.

All these females are conspecific; 15 years ago they would have been placed in the former genus *Sysphincta* with no difficulty. The clypeus is angularly produced in the middle, the petiole is somewhat nodiform in profile (though less so than is usual), the gastric configuration is more nearly that of *Sysphincta* than *Proceratium*, and the wing venation is typical of *Sysphincta*. As pointed out above, Cook erred in assigning his species to *Proceratium*; it should have, at that time, been placed in *Sysphincta*, with which it agreed in all essential characters. It was this realization, especially, which led me to assume that the females were also conspecific with Cook's species; both the male type and the alate females are typically *Sysphincta* in both habitus and structure and therefore readily separable from most of the Nearctic forms. In addition, there was the fact that no other members of this group had been previously discovered in California.

COMPARATIVE NOTES ON *PROCERATIUM* SPECIES

Dr. Brown has very generously sent me specimens of a number of species of *Proceratium* for comparison with California material. The three eastern United States species, *P. croceum* (Roger), *P. pergandei* (Emery), and *P. silaceum* Roger, are represented in this material. From *P. croceum* and *P. silaceum*, the California females may be separated immediately by the produced clypeus and more nodiform scale. Both of the species lack any indication of an angular projection on the clypeal margin and the petiolar scale is fully erect and compressed from front to back so that it is much higher than long. The resemblance to *P. pergandei* is much closer, but fundamental differences are abundant. The paired carinae of the middle clypeal lobe of *P. pergandei* form a broad-based inverted "V" near the apex of the lobe which coalesce well below the level of the antennal sockets, the occipital margin is distinctly convex in full face view, the head, in full face view is not so markedly narrowed above the level of the eyes, the petiolar node is more depressed, the ventral petiolar projection is spine-like and directed caudad and the gastric configuration is quite distinct. In the females here associated with *P. californicum* the clypeal carinae form a much elongated inverted "V" and coalesce above the level of the lower margin of the antennal sockets, the head is markedly narrowed above the eyes, and the ventral petiolar process appears as a blunt, somewhat triangular lamella directed cephalad.

When compared with the Central American species, *P. micrommatum* (Roger), there are no obvious close relationships. In *P. micrommatum*, total length is much less, the antennal scapes are shorter and the petiolar and gastric configurations are different. Three of the Neotropical species, *P. convexiceps*

(Borgmeier), *P. mancum* Mann and *P. brasiliense* Borgmeier, are unknown to me except from their descriptions, which indicate, however, they are also quite distinct from the California form.

In short, *P. californicum* differs significantly from all its North American and Neotropical congeners and does not show any noteworthy affinity with any of these species.

In its general habitus it is obviously much more closely related to the Eurasian species, *P. melinum* (Roger), a member of the *melinum* group of Brown. This group includes also the Japanese species, *P. itoi* (Forel). Although the latter is not available, Dr. Brown sent me a female of *P. melinum* and comparison with that species is possible. When *P. californicum* and *P. melinum* are placed side by side, the similarity is striking; in size, color, punctuation and configuration these ants are obviously very close. In *P. melinum* the occipital margin is evenly convex whereas in *P. californicum* the border is distinctly concave in the middle; the antennal scape is noticeably shorter in the Eurasian species, in full face view barely attaining the level of the hind margin of the posterior ocelli; in *P. californicum* the scape extends slightly above the level of the posterior ocelli. The frons is densely punctate, appearing granulose, and dull in *P. melinum*; in the case of *P. californicum* the punctures are finer, less distinct and the surface is slightly shining. Thoracic punctuation offers an excellent character for separating the two species. Although it is consistently coarser and denser everywhere in *P. melinum*, the distinction is most marked on the mesoscutum. Here, in *P. melinum*, the punctures are very crowded, with the surface appearing subgranulose; the individual punctures are difficult to distinguish. The mesoscutal punctures of *P. californicum*, while abundant, are discretely separated by shining interstices. The second gastric segment of *P. melinum* is abundantly marked by distinct punctures which are only slightly finer than those of the mesoscutum, obviously much larger than the diameter of the hairs arising from them. The Nearctic species has a very finely punctate second gastric segment, the punctures only slightly larger in diameter than the hairs arising from them, much finer than the mesoscutal punctures. The petiolar process of *P. melinum*, in lateral view, has the surface between the anterior and posterior angles emarginate, so that two spines are formed, one directed obliquely cephalad and the other obliquely caudad. In *P. californicum* the process is not emarginate and the entire, somewhat triangular process, is obliquely directly cephalad.

The above comparative comments apply solely to the females. The rarity of males makes it difficult to relate the type specimen to the males of other species. The clypeal configuration, wing venation and shape of the petiolar node adequately separate *P. californicum* from *P. croceum* and *P. silaceum*. I have seen no males of *P. pergandei*; that caste was described by M. R. Smith (1928), but not in sufficient detail for adequate comparative remarks. The following comments are therefore tentative. The length of the male described by Smith is given as 3.6 mm so that it may be seen that the western species is

about 0.5 mm larger. In *P. pergandei* the head, "when measured from side to side thru the eyes," is said to be slightly broader than long; when measured in this manner, the head of the male of *P. californicum* is about 1.3 times as broad as long, which I would be inclined to call distinctly broader than long.

Smith's statement that the pronotum is "somewhat concealed by the mesonotum" would seem to imply that the latter overhangs the former; this condition is not true of *P. californicum*. In this species, the posterior face of the pronotum is vertical and is not overhung by the mesoscutum. The gaster of *P. pergandei* is described as smooth and shining; since Smith noted the presence of punctures elsewhere on the body and made no mention of gastric punctures, I assume he meant there were no evident punctures, although very fine, piligerous punctures must surely be present. The first gastric tergum of Cook's species is conspicuously and closely punctate; the second segment is likewise conspicuously punctate, but the punctures are notably sparser and somewhat finer than on the first segment.

Males of the European species, *P. melinum*, have not been available to me. Although this caste was described by Emery (1895), the description is not sufficiently detailed to be of much assistance here. The size of Emery's male and the mention of abdominal punctures may corroborate the relationship to *P. californicum* suggested by the females of these species.

The evidence examined above indicates that *P. californicum*, based on a male specimen, is distinct from previously described species of New World *Proceratium*, while there is some indication that it may be more nearly related to the European species, *P. melinum*. This accords with what is known of the presumed females of *P. californicum* which are clearly distinct from those of the other known species of the New World. It is on the basis of the relationships expressed above that I have associated these females with *P. californicum*.

The following key has been prepared to facilitate the identification of females and workers of the described species of *Proceratium* occurring in the New World. The following three species are placed in the key on the basis of comments in the literature as they have not been available to me: *P. brasiliense* Borgmeier, *P. convexiceps* (Borgmeier) and *P. mancum* Mann.

KEY TO NEW WORLD *PROCERATIUM*, WORKERS AND FEMALES

1. Petiole erect, compressed from front to back; middle lobe of clypeus not produced forward as a triangular process; females with distinct thin, blade-like process on middle of metanotum and with strong longitudinal carina on apical one-half or more of scutellum.....2
- Petiole nodiform, anterior face convex or strongly inclined, not compressed (except in *P. californicum*); clypeus produced medially as a narrow triangular lobe (except in *P. convexiceps*); female without blade-like process on metanotum; longitudinal carina usually absent from scutellum, when present, very faint, limited to posterior one-fourth, or less, of the segment.....4

2. Larger species, 3.75 to 4 mm; petiolar node, in profile, thick, blunt above, base little thicker than crest; frons with longitudinal carina extending forward between frontal lobes to clypeal base; sides of thorax coarsely rugose (eastern U.S.).....*croceum* (Roger)
- Smaller species, 2.75 mm or less; petiolar node, in profile, slender, base distinctly thicker than crest; frons with longitudinal carina ending at midpoint, or less, of distance toward clypeal base; sides of thorax with a few irregular rugulae, but mostly smooth.....3
3. Epinotal spines distinct; genal area punctate, distinctly shining; dorsum of thorax without pronounced transverse rugulae behind (C. Amer., s. Mex)*mancum* Mann
- Epinotum without distinct spines, but angulate laterally at juncture of basal and declivous faces; genal area strongly rugulose; dorsum of thorax with prominent transverse rugulae behind (eastern U.S.).....*silaceum* (Roger)
4. Small species, 3.5 mm or less; head broadest above, slightly but definitely narrowed toward mandibular insertions; frontal carinae approximate, subparallel (except in *P. brasiliense*) (Central and South America).....5
- Larger species, 3.75 mm or more; head little, if any, narrowed toward mandibular insertions, broadest below level of eyes; frontal carinae well-separated, convergent above (U.S.).....7
5. Clypeal margin not medially produced.....*convexiceps* (Borgmeier)
- Clypeal margin slightly to strongly produced in middle.....6
6. Eyes very small; frontal carinae convergent anteriorly; ventral petiolar process bispinose.....*brasiliense* Borgmeier
- Eyes larger, well-developed; frontal carinae parallel; ventral petiolar process with a single spine.....*micrommatum* (Roger)
7. In full face view occipital margin convex, sides of head sub-parallel to top of head; clypeal carinae forming inverted broad-based "V" near apex; ventral petiolar process forming a narrow spine obliquely directed caudad; reflected dorsum of second gastric segment strongly projected to rear so that reflected tip of gaster appears to arise from mid-ventral surface*pergandei* (Emery)
- In full face view occipital margin with median concavity, head distinctly narrowed above; clypeal carinae forming elongated inverted "V" before coalescing between frontal lobes; reflected dorsum of second gastric segment not strongly projecting to rear, forming an even curve with reflected tip.....*californicum* Cook

During the preparation of this paper I have been supplied with material from several institutions. Especially helpful has been Dr. W. L. Brown, Jr., Cornell University, who sent specimens which would not have been otherwise available; Dr. Brown has also read and criticized the manuscript. The holotype of *P. californicum* was made available through the courtesy of Dr. C.

Don MacNeill, Snow Museum, Oakland, California. Dr. Marius Wasbauer sent the Yuba City specimen from the collection of the Bureau of Entomology, California Department of Agriculture. To these gentlemen, my very sincere thanks. To my wife, Ruth Ann, special thanks for the care and diligence with which she executed the habitus illustrations.

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